for example, to begin the automated fill process. As shown in FIG. **47**, the control system **700** may actuate the peristaltic pump **200** to operate in reverse while opening the valve **265** to allow a predetermined volume of the dilution solution, as set by the user, to flow from the dilution container **260** into the bulk product vial **100**.

As shown in FIG. **48**, the valve **265** may be closed to the dilution container **260** and nitrogen forced through the system to purge any remaining dilution solution from the peristaltic tubing leading to the bulk product vial **100**. In doing so, nitrogen may be bubbled through the diluted radiopharmaceutical product in the bulk product vial **100** before exiting through the vent filter, for example, further helping to mix the diluted product.

In accordance with another aspect of the present invention, rather than using nitrogen to clear the lines, for example, the peristaltic pump **200** may be operated to return a small amount of the diluted product back to the CAV container **1502**. The pump **200** may then be reversed again to return the small amount of diluted product from the CAV container **1502** back to the bulk product vial **100**. Thus, any small amount of liquid that may be left remaining in the CAV container **1502** or the lines from the CAV container **1502** to the dispensing manifold assembly **300** will be diluted, rather than concentrated.

As shown in FIGS. **49** and **50**, the control system **700** may operate the pump **200** to fill the manifold tubes **310** with the diluted product up to the furthest final product vial **400** or **405**. The control system **700** may then begin filling the vials from right to left, for example, starting with the sterility vial **450**, followed by the quality check vial **482**, and then each of the final product vials **400** and **405**. Although described in a particular order herein, the control system **700** may be configured through user input via the computer system **1200** to fill the vials in any order.

As shown in FIG. **51**, excess diluted product in the bulk product vial **100**, along with excess diluted product in the peristaltic tubing and the manifold tubes **310**, for example, may be purged using nitrogen and collected in a final product vial **405** connected to the manifold tube **310** furthest from the pump **200**. As shown in FIGS. **52-55**, the fill process may be completed by purging any diluted product remaining in the lines to the vials, for example, preferably beginning with the vial farthest away from the pump and continuing with each closer vial until all of the vials have been purged.

In accordance with another aspect of the present invention, as shown in FIG. **56**, a rinse, such as water, or any other suitable cleansing fluid, may be provided from the synthesis unit to further clean the disposables of possible radioactive residue. The rinse may be delivered from the synthesis unit through the line **565** and deposited into the CAV container **1502**. Once the rinse is delivered to the CAV container **1502**, the user may select a "Start Rinse" command, for example, to begin the rinse process. As shown in FIGS. **57** and **58**, the control system **700** may actuate the peristaltic pump **200** to operate in a reverse direction in order to transfer the rinse from the CAV container **1502** to the bulk product vial **100**. As shown in FIG. **59**, with the CAV container **1502** and the fluid lines between the CAV container **1502** and the bulk product vial **100** thus rinsed, the peristaltic pump **200** may be operated to draw the rinse from the bulk product vial **100** and force the rinse through the manifold tubes **310** to the waste receptacle (not shown). In accordance with yet another aspect of the present invention, as shown in FIG. **60**, the peristaltic pump **200** may continue to operate in order to draw in atmospheric air, for example, through the vented bulk product vial **100** and pump the air through the lines and the manifold tubes **310** until all of the rinse is deposited into the waste receptacle.

In accordance with yet another aspect of the present invention, as shown in FIGS. **61-65**, the remaining dilution solution in the dilution container **260** may be used to perform another rinse of the disposable components. As shown in FIG. **61**, the valve **265** may be opened and the peristaltic pump **200** operated to pull the remaining dilution solution from the dilution container **260** into the bulk product vial **100**. Once the remaining dilution solution is in the bulk product vial **100**, as shown in FIG. **62**, the valve **265** may be closed to the dilution container **260**, the valve **266** may be opened to allow fluid communication between the bulk product vial **100** and the CAV container **1502**, and the peristaltic pump **200** may be operated in reverse to pull the dilution solution from the bulk product vial **100** and pump the dilution solution into the CAV container **1502**.

As shown in FIG. **63**, once the dilution solution has been pumped into the CAV container **1502**, the process may be reversed by reversing the direction of the pump **200** and the dilution solution transferred back to the bulk product vial **100** from the CAV container **1502**. With the fluid path between the bulk product vial **100** and the CAV container **1502** thus rinsed, the valves **265** and **266** may be opened to allow fluid flow through the manifold tubes **310**. As shown in FIG. **64**, the dilution solution may then be pumped out of the bulk product vial **100** and through the manifold tubes **310** to the waste receptacle (not shown). As shown in FIG. **65**, the peristaltic pump **200** may continue to operate in order to draw in atmospheric air, for example, through the vented bulk product vial **100** and pump the air through the system until all or substantially all of the dilution solution is forced from the manifold tubes **310** and into the waste receptacle (not shown).

As described previously, the vials may then be removed from the system **10** for transport in a shielded container to the appropriate location for testing and/or use in a procedure. The disposable components of the system **10** may be removed and discarded according to the proper protocol and the system prepared for another run.

The previous description is provided to enable any person skilled in the art to practice the various exemplary implementations described herein. Various modifications to these variations will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other implementations. All structural and functional equivalents to the elements of the various illustrious examples described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference.

The invention claimed is:

1. A closed path vial fill system, comprising:

a bulk product vial containing a bulk product;

a first tube element inserted into a peristaltic pump, wherein the first tube element is coupled with the bulk product vial;

a dispensing manifold assembly coupled with the first tube element;

at least one final product vial coupled to the dispensing manifold assembly;

a valve disposed between the peristaltic pump and the dispensing manifold assembly, the valve having a first position and a second position; and

a dilution container having a dilution solution, wherein the dilution container is coupled to the valve,

wherein in the first position, the valve allows fluid to flow from the dilution container to the bulk product vial,